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US Progress in Failure Rate Data Work

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Four Topics to Discuss

- Generic data harvesting
- Tokamak component data analysis
- Tritium system component data analysis
- Task 5 progress

Generic data harvesting progress

- At our 3rd meeting, the future plan was to harvest data on remote handling and robotic equipment. This work was begun, and then it was deferred to 2004.
- Another data harvesting task to consider is data on plasma diagnostic devices. This work depends on resources allocated in 2004.
- The reliability of pipe coatings, such as AlN insulator coatings, may require examination in 2004.

Tokamak component data analysis progress

- Initial work was for vacuum system components, this was published recently from the 15th TOFE in November 2002.
- An ITER need is to enhance the personnel safety aspects of the design.
  - An analysis of the DIII-D tokamak personnel safety oxygen monitors was performed. The results will be presented at the 20th SOFE.
    - Monitor failing to operate is 2.6E-06/h, UB = 1.1E-05/h
    - Monitor false alarm is 4.6E-05/h, UB = 7.4E-05/h
- Working with DIII-D trouble report data has been productive; tokamaks yield more than just physics data.
- Peter Petersen at DIII-D is very positive about supporting Task 5; more data analysis work is planned.

Tokamak component data analysis progress (con't)

- DIII-D is an older experiment, first plasma was in February 1986.
- The age of the machine presents a dilemma. Due to its age, we can obtain meaningful failure rate statistics from studying the operating experience data. But, due to its age, some of the DIII-D components would no longer be used in next-generation tokamaks.
- DIII-D is not a tritium machine, so some components will not have the severe challenge they would in a future machine like FIRE or ITER.
- Not all of the DIII-D systems or components will apply to near-term fusion designs.

Tokamak component data analysis progress (con't)

- DIII-D systems that I believe are applicable to future experiments:
  - vacuum system
  - plasma heating (ECRH, ICRH)
  - plasma diagnostics, in general
  - safety monitors/sensors for these systems
  - personnel safety systems
  - vacuum vessel air/water circulation system
- DIII-D data analysis will support ITER. At present, I have not selected a DIII-D system for analysis in 2004.
- The DIII-D data work will continue at a modest pace, perhaps 1 system studied each year.
- In 2002, Charlie Neumeyer of NSTX agreed to allow similar analysis when their TR database has grown.

Tritium system component data analysis

- Tonio Pinna discussed his work with tritium and vacuum system data. These systems are important to plant safety; they contain the largest radiological inventories in a fusion facility.
- These data are important to safety assessment; all parties have made an effort to study tritium component failure rate data.
- Past work from 2000 has shown good agreement between US and Japanese tritium component failure rates.

Tritium system data analysis (con't)

- In August, Scott Willms (formerly of the Tritium Systems Test Assembly at Los Alamos) sent me a computer file of the TSTA trouble reports. Reporting was suspended when funding began to decline in the mid 1990's.
- Update of the four TSTA data reports may be possible:
  - The glovebox nitrogen waste gas system from 1990
  - The tritium room monitors from 1991
  - The tritium gloveboxes from 1992
  - The experimental tritium cleanup system from 1993

Tritium system data analysis (con't)

- I propose to update the TSTA component failure rate data to 1995 and compare values to Tonio's published JET and TLK data, and the Japan TPL data that was published by M. Yamada et al., FS&T, vol. 41, May 2002.
- Developing a good set of tritium component failure rates, independently verified by several countries, should support the ITER design team in their effort to obtain regulatory approval of the ITER tritium plant.
- Our data do not yet have the pedigree of fission power plant data, but "an analyst has to start someplace." Even fission analysts admit that the LER data do not yield true failure rates.

The basic direction of Task 5

- This task began in 1989 at the IAEA Developments in Fusion Safety meeting (and IEA meeting) in Jackson, Wyoming.
- The task focus was primarily to develop a data handbook component failure rates to support PRA, probabilistic SARs, system reliability studies, and plant availability studies.
- The initial idea was to create something for fusion similar to the IEEE Std-500 book of component failure rates.

Task 5 progress over time

- From its inception, this task has been highly specialized, with only a few participants.
- Tonio Pinna has led a computerized data base development effort at ENEA. By Tonio's efforts, the database exists. It currently stores several hundred harvested failure rate values - and it will hold more.
- Initially we 'harvested' or 'mined' data values from other industries (fission, accelerators, aerospace, others). Some values were used for ITER safety studies. The harvesting work continues.
- Our task developed a dual effort; one was to continue data harvesting to support existing safety tasks, and the other was to analyze data from tokamaks.

Task 5 progress over time (con't)

- We have begun to analyze failure report data from existing tokamaks, since these are generally the best data to apply to next step fusion experiments. We are now 'data farming' from tokamaks!
- A data review or data validation approach has been agreed upon, where analysts review a database value and assign a 'good', 'fair', or 'poor' rating in comparison to any reference data that is available. This work is just beginning.

Task 5 evolution

- An unexpected collaboration occurred in the late 1990's with the analysts performing ORE estimation. They wish to know equipment repair times; the equipment repair times indicate the time at risk in a radiation field.
- Over time, we have begun to consider the task as more than simply collecting reasonable failure rate values. The task has grown to include historical operating experiences from fusion experiments and test facilities.
- This task supports safety assessment of next-step fusion experiments.

Conclusions

- We know that these data are expensive to generate, so we must make judicious choices in where we spend our resources.
- Data "harvesting" from the literature will continue. My plan is to continue with the remote handling data work in 2004 unless the diagnostics or another system presents a more pressing need.
- Data "farming" from DIII-D will continue. Our discussions this afternoon should help to identify a system to analyze during 2004.
- The tritium component failure rate data comparison should help support ITER.
- This IEA task is producing meaningful work to support safety assessment of fusion facilities.